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HOSELIKE MEMBER HAVING A CIRCUMFERENCE WHICH IS COMPOSED OF A NUMBER OF METAL WIRES OR TUBES

The invention relates to a hoselike member having an external wall composed of a number of metal wires, or tubes.

Such hoselike members are generally known and are used as protective hose for guiding longitudinal objects, such as electrical cables, fluid lines, etc., especially in cars. The walls of these hoselike members are generally composed of metal wires that are woven, usually round woven, so as to form a generally continuous surface.

These known hoselike members fulfil these functions in a satisfactory way. Nevertheless, there is need for similar members with lightweight constructions and for use in other applications.

It is, therefore, an objective of the invention to provide such a hoselike member.

This objective is achieved by ensuring that all the wires or tubes are parallel to each other and by ensuring that the wires or tubes are wound in a helical manner around the axis of the hoselike member.

In this way, a very effective and cheap method of producing hoselike members can be obtained.

Preferably, the metal is aluminium or an aluminium alloy.

By using this type of metal, which is lightweight and easy to bend, it is even possible to obtain a convenient way of producing the hoselike member.

Otherwise, and especially when using tubes, the hoselike member can be used as a flexible connection in a fluid transportation system.

Until now, it has been common to use rubber hoses for these applications, and, if provided with steel filaments, they were even capable of containing high pressures, e.g. for use in hydraulic systems. The property making the rubber hoses well suited to this purpose is their high degree of flexibility, whereby the hoses can connect fixed parts with moving parts. The hoses are also durable, even when subject to vibration. As such, they have frequently been used in automotive systems, in which two components, each having their own vibrating

system, need to be connected by a fluid line, and where a certain degree of flexibility is required. Examples of such applications are air-conditioning systems, fuel supply systems, brake lines, etc.

As a material, however, rubber suffers from the drawback that at least some fluid, in gas form, may diffuse through the material. In vehicle braking systems, water enters into the brake fluid by diffusion through the flexible rubber hose connections. In air-conditioning systems, especially those based upon carbon dioxide, the carbon dioxide slowly escapes through the rubber hoses, resulting in poor performance of the systems, and time-consuming and costly refilling is necessary. A further disadvantage of rubber is aging, which normally occurs in all outdoor conditions. As a result thereof, rubber moulders away and needs replacement at time-intervals dependent upon its application. Moreover, the tensile strength of rubber is relatively low, and does not make it very suitable for high-pressure applications.

It is, therefore, an aim of the invention to provide a hoselike member having a circumference formed by a number of metal tubes, where all the tubes are substantially parallel to each other and are wound in a helical manner around the longitudinal axis of the hoselike member.

Other characteristics and advantages of the invention will become clear from the following descriptions, which refer to the annexed drawings:

Fig. 1 shows a side view of a hoselike member corresponding to the invention.

Fig. 2 shows a side view of a hoselike member in a fluid transport application.

Fig. 3-5 shows a side view of other examples of a hoselike member in a fluid transport application.

Fig. 6-7 show a cross section of an example of a hoselike member corresponding to section A-A of Fig. 4.

Fig. 8 shows a cross section of an example of a hoselike member corresponding to section B-B of Fig. 5.

Fig. 9-11 show cross sections of an example of a hoselike member corresponding to section A-A of Fig. 4.

Fig. 12 shows a side view of an example of a hoselike member.

Fig. 13 shows section C-C of Fig. 3.

Fig. 14 is a graph showing schematically the change in compliance and strength in relation to the diameter of tubes or wires used to make the hoselike member, according to the invention.

Fig. 15 is a graph showing schematically the variation in compliance, and the relation ship between pressure drop and the wall thickness of a tube or wire with fixed diameter to form the hoselike member according to the invention.

Fig. 16 is a graph showing the variation in flexibility versus the twisting angle for a hoselike member according to the invention.

Fig. 17 is a perspective view of a modified example of the end-connector (manifold) to be used in connection with the hoselike member according to the invention.

Fig. 1 shows a hoselike member (1) comprising a number of helically wound or twisted wires or tubes (2). The hoselike member can be made by helically winding a number of wires or tubes around a core member of the required cross-sectional shape, e.g. round, oval or any useful configuration, following which the core member is removed from the resulting hose-like member. It is thus possible to either have the neighbouring wires or tubes so close together that a hoselike member with a closed surface is obtained, or to have some distance between adjacent wires or tubes and obtain a semi-closed surface offering more flexibility. The central part of the hoselike member (1) may be either hollow or filled with a core material (10) (see fig. 6), dependent upon the application for which the hoselike member is to be used. Such a hoselike member (1) forms a flexible member which can be elastically deformed in a direction perpendicular to its longitudinal axis, i.e. it can be bent and absorb vibrations in that direction. Furthermore, a flexible deformation in the longitudinal direction is also possible.

The wires or tubes making up the hoselike members are preferably made of aluminium or aluminium alloys, which offer good deformability, flexibility and durability – useful features for the production and the application of the hoselike member.

In cases where the central part is hollow, the hoselike member can be used as a protective guide for sensitive longitudinal elements, such as electrical cables, flexible hoses, etc. This is a preferred application in automotive vehicles, but it may also be used in other situations. In such applications, each end portion of the hoselike member (1) may be covered in order to protect the ends of the wires or tubes (not shown). When this protection is required, a closed surface may be preferred, but in a number of applications, it is only the guidance that is important so that a semi-open surface can be used.

In such applications, the elements making up the hoselike member may be either wires or tubes, and, where necessary, the hoselike member may be longitudinally preformed so as to provide the required guiding of the longitudinal elements.

In other applications the hoselike member is intended to be used as a flexible fluid connection between two rigid fluid lines, or implements. In this type of application, the hoselike members must be made out of wound or twisted tubes.

Fig. 2-5 show hoselike members (1) comprising wound or twisted tubes (2) and end pieces or manifolds (4). The end pieces (4) may be used to assemble the flow paths of the tubes to one common flow path or, conversely, to distribute one flow path into the tubes (2). In Fig. 3 and 4, the pitch angle V is shown. The pitch angle is the angle into which the tubes are wound or twisted. The tubes (2) may be wound or twisted into any shape, e.g. helical, spiral, coil, as well as given a varying pitch angle or diameter, or with combinations of any such shapes.

In Fig. 2, unwound or untwisted straight and parallel tubes (2) have initially been placed with each end into two end pieces (4) (only one is shown), with a core member (not visible) (10) placed centrally to the tubes (2). The end pieces (4) have then been twisted relative to each other and, thereby, also the tubes (2), until the tubes (2) have obtained a permanent twist and maintain the depicted shape. This is a preferred way of manufacturing the system (1). The tube (2) would normally be glued, brazed or welded to the end pieces (4) to form a tight connection. Following these processes, the system (1) may have a further polymeric

protective member (12) (Fig. 10) cast around it, whereby it becomes at least partly embedded. Alternatively, the core carrier may be removed before the protective carrier (12) is added (Fig. 11).

Fig. 6 and 7 display a hoselike member (1), where multiple tubes (2) are placed to surround a cylindrical carrier, which in these cases are core members (10). The core member is made of a polymeric material, preferably an elastomer such as polyurethane. In Fig. 6 the tubes are placed in one layer (6), whereas in Fig. 7 the tubes are placed in two layers (6) and (8). With more layers, a larger flow area may be obtained, thereby decreasing the flow resistance through the tube system without increasing the outer diameter of the system (1).

Fig. 8 displays a hoselike member (1), where a number of wound or twisted tubes (2) are placed at a distance from and parallel to the longitudinal axis of a core member (10) comprising a central cavity 11.

Fig. 9 displays a pipe system (1), where six tubes (2) are placed to surround a core member (10).

Fig. 10 displays a hoselike member (1), where six tubes (2) are placed to surround a core member (10). The tubes (2) are further embedded in a protective carrier (12).

Fig. 11 shows a hoselike member (1) comprising multiple tubes (2) placed in two layers (6) & (8). The tubes (2) are embedded in a protective carrier (12) comprising a central cavity (11).

Fig. (12) shows a hoselike member (1) comprising manifolds (4) and a spiral section (14) and a straight section (16). This design is well suited for applications requiring very high flexibility. Of course, the hoselike member may comprise further spiral and/or straight sections.

Fig. 13 displays a manifold (4) comprising mounting holes (18) distributed in a suitable pattern for receiving the pipes (2). The holes (18) are connected to a central opening (20).

The hoselike member (1) may be used in high pressure systems carrying gas, air, water, steam, petrochemicals or any other substance in order to allow individual movement of the equipment and the connecting lines. The member (1) may also be used in braking systems

on vehicles and other means of transport. In these types of applications it may be used with or without a core carrier.

The degree of flexibility of a tube system is, according to the invention, defined by a number of characteristics of the tubes to be used.

For a tube of a given material, the compliance perpendicular to the longitudinal direction is dependent upon the diameter of the tube, and the wall thickness. Fig. 14 illustrates the variation of the compliance (C) of a tube having a fixed wall thickness in relation to the diameter. It is clear that the compliance will increase as the diameter increases. Furthermore, and as shown in Fig. 15, the compliance of a tube with a constant diameter increases as the wall thickness increases.

Otherwise, the burst pressure (BP) of a tube of a defined material is dependent upon the diameter. In fig. 14, the variation of burst pressure is shown as a function of the diameter, and it is clear that it decreases as the diameter increases. In fig. 15, the variation of the pressure drop as a function of the wall thickness is shown, and it follows that the pressure drop increases as the wall thickness increases, the diameter being constant.

In order to make a flexible system, having sufficient compliance, sufficient mechanical strength, especially resistance to internal pressure, and the lowest possible pressure drop it is important to use tubes with a diameter and a wall thickness that provide a compromise between those requirements.

Tests have shown that the most adequate tubes will have an internal diameter between 1 and 6 mm and a wall thickness between 0.1 and 0.5 mm.

Preferably the internal diameter is between 2 and 4 mm, whereas the wall thickness is close to between 0.2 and 0.4 mm.

Otherwise, it has been found that the degree of flexibility or compliance is dependent upon the pitch angle V, i.e. the angle between the helical wound tube and the longitudinal axis of the pipe system (see figure 16). Also here, there is a compromise between the pitch angle V and the mechanical strength of the system, as especially its axial strength must be sufficient

to maintain the pipe system in the right position. It is, therefore, preferable to have a pitch angel V of between 50° and 85°. Ideally, the pitch angle should be between 60° and 80°.

Fig. 17 shows a manifold, or connecting piece (25), which can be used for connecting a hoselike member composed of a number of capillary tubes to a single tube.

The construction of this connecting piece is almost identical to the one described in EP-B-0 895 051.

It is to be understood that the invention as disclosed in the description and in the figures may be modified and changed and still be within the scope of the invention as claimed hereinafter.